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DATA FROM CONTROLLED DRILLING PROGRAM IN KANE COUNTY, ILLINOIS

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ILLINOIS STATE GEOLOGICAL SURVEY

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ABSTRACT

Samples of earth materials were collected at eight sites in Kane County, Illinois, as part of a controlled drilling program for ground-water exploration in northeastern and north-central Illinois. Descriptions of the character and sequence, tables listing relative density, relative consistency, moisture content, and size analyses, and gamma-ray logs are presented for the glacial materials sampled and tested in the program.

INTRODUCTION

In the Chicago region and in other areas of northern Illinois, the deep sources of water, the artesian sandstones, are already overpumped. To seek information on the nature of glacial deposits in order to facilitate the search for new, shallow sources of ground water for the rapidly expanding metropolitan areas of northeastern and north-central Illinois, the Illinois State Geological Survey has conducted controlled drilling programs. Data compiled from field and laboratory analyses of samples collected from eight drill holes in Kane County are presented here (fig. 1). The test holes were drilled in conjunction with an aquifer-evaluation study by the Illinois State Water Survey.

The Geological Survey's role in the investigation was to obtain, by controlled drilling, sampling, and testing, detailed information on the glacial deposits in the larger buried valleys in Kane County. These valleys were believed to have a reasonably good potential as a source of ground water. Previously, little test drilling had been done to determine the nature of the valley deposits and their ground-water potential.

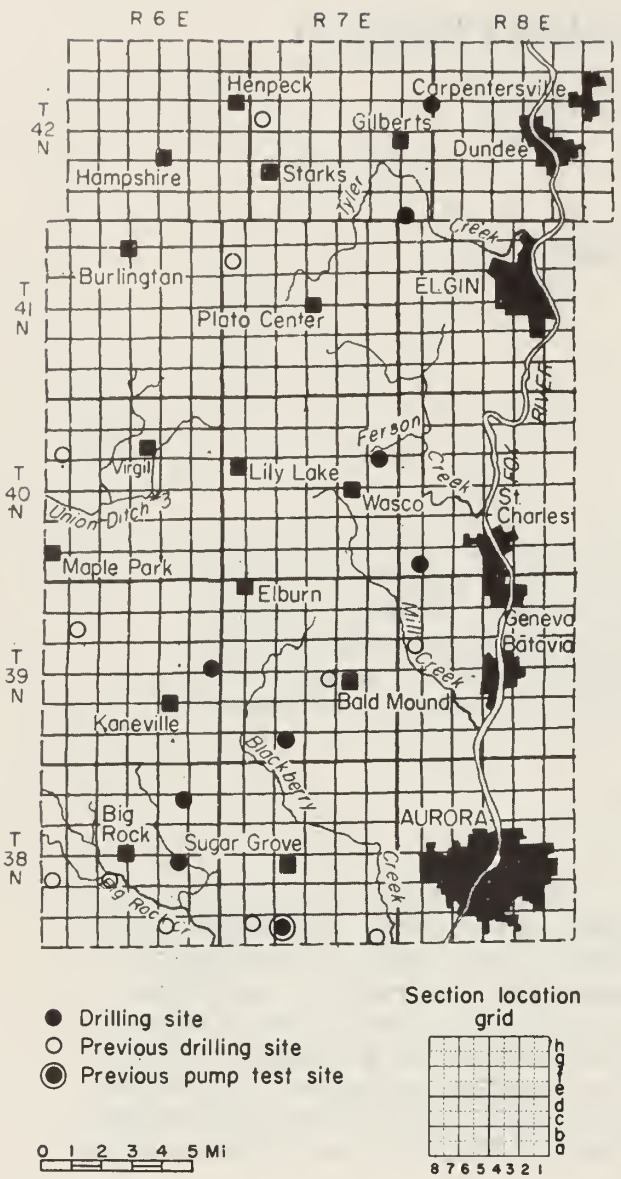


Fig. 1 - Location of drilling sites in Kane County.

The Illinois State Water Survey has made quantitative appraisals of the water-yielding potential of the glacial deposits at selected sites in northeastern and north-central Illinois. In subsequent reports the Geological Survey will present geologic interpretations of the data reported here. The results of controlled drilling programs conducted in 1962-63 and in 1970 were reported in earlier Environmental Geology Notes (nos. 2, 6, 7, 9, 10, 53, and 71).

Data from controlled drilling programs can be applied to other environmental problems in northeastern and north-central Illinois in addition to the availability of ground water. These investigations (1) supplement existing information on the character and distribution of glacial materials that may be usable mineral resources, that may present construction problems, or that affect the disposal of wastes; and (2) provide a basis for interpreting other types of subsurface information, such as drillers' logs of water wells or records of foundation borings. For example, the drilling provided representative, relatively undisturbed split-spoon samples of earth materials that can be used to determine the physical and chemical properties that commonly affect land use.

The exploratory test holes were drilled by Layne-Western Company of Aurora, Illinois, under the supervision of the Geological Survey. Locations for the test holes selected by the Geological Survey were generally along the rights-of-way of county roads. Landowners and utility companies were consulted about buried tiles, cables, and pipelines in the area. County and township road supervisors, county zoning and planning officials, and county health officers were apprised of the scope, progress, and results of the testing.

FIELD OPERATIONS

Drilling

The drilling contractor was provided with a log of the anticipated thickness and character of the deposits extending to bedrock, instructions on testing procedures, and a list of depths to be sampled with a split-spoon sampler. A mobile Sanderson-Cyclone hydraulic rotary drill rig was used for the drilling. The support equipment consisted of an 18-foot tilt trailer, a 1,000-gallon flat-bedded water truck, an enclosed 12-foot test site trailer, and a 1½-ton truck with a rear mounted backhole. The crew at the rig normally was made up of a driller, a driller's helper, and a Survey geologist. During drilling, conventional rotary samples were obtained, split-spoon samples were taken at selected intervals, and a log was made of the materials penetrated.

Interconnected settling and suction pits of about equal size were used during the program to keep the drilling mud at optimum viscosity and weight. The mud losses during drilling and between work periods were recorded for each boring. Natural mud alone was used to start test holes, but eventually bentonite and, periodically, caustic soda were added to improve mud properties. Density and viscosity of the drilling mud were determined with a standard mud balance and a Marsh funnel.

Sampling

Rotary samples were collected at 5-foot intervals from the open ditch near the drill hole. The drilling mud was circulated until a representative sample was collected from each interval. The samples were washed in a 5-gallon bucket, air dried, and then bagged.

Split-spoon samples were obtained with a sampler having an outside diameter (OD) of 2 inches. The split-spoon was lowered inside a full-hole 4½-inch OD drill pipe on AW-Rod (OD 1¾ inches) with flush-joint straight thread. The spoon was then driven 18 inches by a 140-pound hammer that fell 30 inches or, where noted, by a 300-pound stem and jar that fell 27 inches. The rotary cuttings and the split-spoon samples are on file at the Geological Survey.

Measurements of the unconfined compressive strength of cohesive materials (primarily clay till) were made on each split-spoon sample with a Soiltest Model CL-700 pocket penetrometer immediately after the sample was obtained. A small portion of each cohesive sample was sealed in a bottle for determination of natural moisture content.

The relations between descriptive terms and quantitative expressions for relative density and relative consistency are as follows:

Relative density

Description	Blows/ft
Very loose	0 - 5
Loose	5 - 10
Medium dense	10 - 30
Dense	30 - 50
Very dense	50+

Relative consistency

Description	Qp* (tons/ft^2)
Very soft	0.0 - 0.25
Soft	0.25 - 0.5
Medium	0.5 - 1.0
Stiff	1.0 - 2.0
Very stiff	2.0 - 4.0
Hard	4.0+

* Unconfined compressive strength measurement made with pocket penetrometer.

ELECTRIC LOGGING AND NATURAL GAMMA LOGGING

Spontaneous potential (SP), single-point resistivity, and natural gamma logs were run in mud-filled test holes with a Neltronic logger (IK Model D). The logs, which are on file at the Geological Survey, were useful in the interpretation of the lithologic sequence, character, and thickness of the glacial deposits sampled and tested in the program. The natural gamma logs are shown for each site tested.

LABORATORY TESTS

Size-Distribution Analyses

Hydrometer analyses were used to determine the amount of clay (particle diameter less than 0.0039 mm) in each cohesive split-spoon sample. Samples of approximately 55 grams were taken, and corrections for temperature and added deflocculants were made. The amount of material coarser than silt (diameter greater than 0.0625 mm) was determined by sieving, and the amount of silt was determined by subtracting from the weight of the total sample the weight of the coarser material plus the weight of clay.

The rotary and split-spoon samples that were friable and noncohesive were sieved with Tyler screens. The dimensions of the sieves and the Wentworth and phi (ϕ) grain-size classifications related to this study are shown in table 1. The upper size limit of the sieved material was about 30 mm in diameter.

TABLE 1—SIEVE DIMENSIONS AND GRADE SCALES

Sieve number		Tyler mesh diameter		Wentworth grain-size classification	Phi (ϕ) scale
U.S. Standard	Tyler	(in.)	(mm)		
4	4	0.1874	4.76	Granules and pebbles (gravel)	
10	9	0.0787	2.00	---------- 2.0 mm ----------	-1.0
				Very coarse sand	
18	16	0.0394	1.00	---------- 1.00 mm ---------	0.0
25	24	0.0278	0.707	Coarse sand	
35	32	0.0197	0.500	---------- 0.500 mm --------	1.0
45	42	0.0139	0.354	Medium sand	
60	60	0.0098	0.250	---------- 0.250 mm --------	2.0
80	80	0.0070	0.177	Fine sand	
120	115	0.0049	0.125	---------- 0.125 mm --------	3.0
170	170	0.0035	0.088	Very fine sand	
230	250	0.0025	0.0625	---------- 0.0625 mm -------	4.0
				Silt	
	Hydrometer separation			---------- 0.0039 mm -------	8.0
				Clay	

IDENTIFICATION SYSTEM

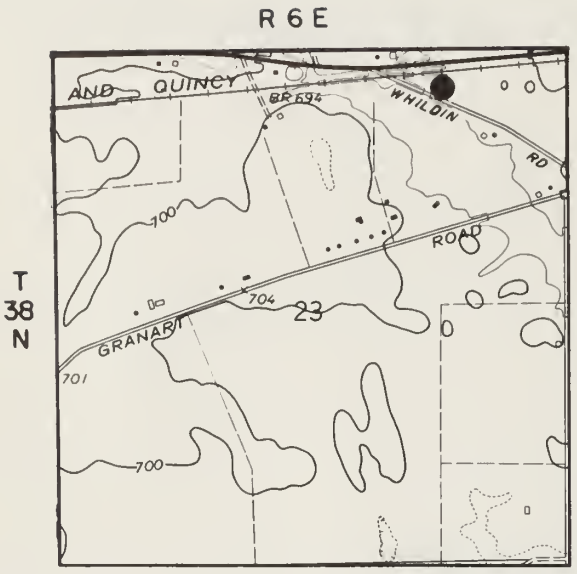
The numbering system used to identify the borings is based on the location of the boring. The number of each hole consists of a county abbreviation and the numbers of the township, range, section, and coordinates within the section. Sections are divided into rows of one-eighth mile squares. Each square contains 10 acres and corresponds to a quarter of a quarter of a quarter section. A normal section of 1 square mile contains eight rows of one-eighth mile squares, and an odd-sized section contains more or fewer rows. Rows are numbered from east to west and lettered from south to north as shown in the grid on figure 1. For example, a well located in square 1h of Section 13, Township 42 North, Range 7 East, would be numbered KNE 42N7E-13.1h.

Location maps for each of the eight borings were duplicated from United States Geological Survey 7.5-minute quadrangle topographic maps (scale 1:24,000, approximately 2½ inches per mile). The borings have been located within the 10-acre coordinate squares with as much accuracy as the scales permit.

The quadrangle topographic map on which the boring is located is identified in the drill record. Elevations for each boring were estimated from contours shown on the topographic maps. Individual quadrangle maps may be purchased from the Illinois State Geological Survey, Urbana, or from the United States Geological Survey, Washington, DC.

DATA FROM THE DRILL HOLES

DRILLING RECORD FOR KNE 38N6E-23.3h



Location of test:

S 500 ft, W 1,450 ft from NE cor. of sec. 23; 200 ft SE from a concrete culvert and 30 ft NE of the center line of Whildin Road (Big Rock Quadrangle, 1968)

Surface elevation: 685 ft
Date started: 7-5-72
Date completed: 7-7-72
Electric log interval: 0-128.0 ft
Natural gamma log interval: 0-128.0 ft

Zones of fluid loss:

38.5-46.0
- Density: 9.5 lb/gal
- Viscosity: 39 sec/qt
- Loss: 105 gal

47.0-60.0
- Density: 9.5
- Viscosity: 39 sec/qt
- Loss: 165 gal

60.0-100.0
- Density: 9.9 lb/gal
- Viscosity: 44 sec/qt
- Loss: 210 gal

100.0-120.0
- Density: 9.9 lb/gal
- Viscosity: 44 sec/qt
- Loss: 75 gal

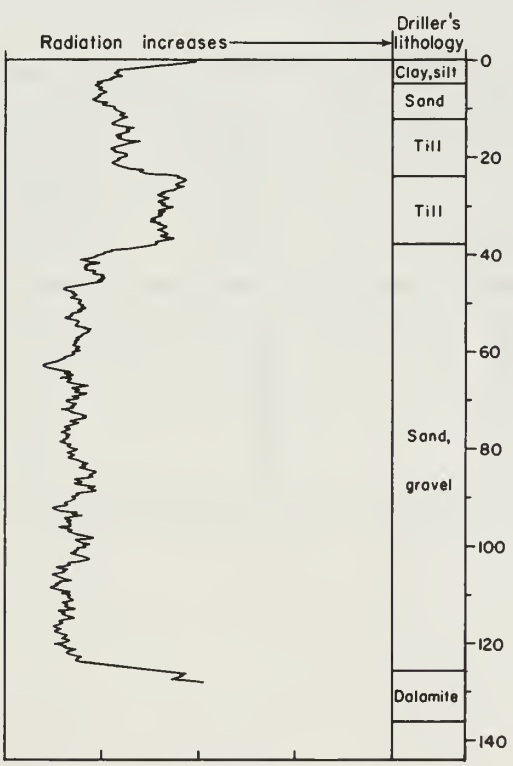
Remarks: Flow of 50 gpm (gallons per minute) developed overnight from the mud-filled borehole 128.0 ft. deep.

KNE 38N6E-23.3h - Continued

DESCRIPTION OF MATERIALS

Description	Thickness (ft)	Depth (ft)
Topsoil, black	1.5	0.0 - 1.5
Till, predominantly clay, brown, sandy, gravelly	1.5	1.5 - 3.0
Silt, brown, sandy	2.0	3.0 - 5.0
Sand and gravel, gray, clayey, silty	7.0	5.0 - 12.0
Till, predominantly clay, gray, silty, sandy, gravelly	9.0	12.0 - 21.0
Sand and gravel, gray	3.0	21.0 - 24.0
Till, predominantly clay, gray, pink cast, sandy, gravelly	14.5	24.0 - 38.5
Sand and gravel, gray, loosely packed	7.5	38.5 - 46.0
Clay, gray	1.0	46.0 - 47.0
Sand and gravel, gray	19.0	47.0 - 66.0
Sand and gravel, brown, tight	6.0	66.0 - 72.0
Sand and gravel, brown	35.5	72.0 - 107.5
Sand and gravel, brown, loosely packed	4.5	107.5 - 112.0
Sand and gravel, brown, small silt layers	14.0	112.0 - 126.0
Dolomite, gray, shaly	10.0	126.0 - 136.0
	Total depth 136.0 ft	

GAMMA-RAY LOG WITH DRILLER'S LITHOLOGY



KNE 38N6E-23.3h - Continued

SPLIT-SPOON SAMPLES

Sample	Depth (ft)	Recovery (in.)	Blows/6-inch hammer drop	N value*	Qp† (tons/ft^2)	Moisture content (%)
1	1.0 - 2.5	14	1- 3- 5	8	1.0	15.6
2	3.0 - 4.5	10	4- 5- 9	14	--	21.4
3	10.0 - 11.5	6	6- 3- 3	6	--	14.0
4	20.0 - 21.5	12	7- 8- 21	29	--	11.8
5	30.0 - 31.5	18	6- 7- 9	16	2.3	13.0
6	40.0 - 41.5	14	15- 20- 20	40	--	--
7	50.0 - 51.5	15	14- 17- 17	34	--	--
8	60.0 - 61.5	13	16- 15- 11	26	--	--
9	70.0 - 71.5	5	19- 31- 26	57	--	--
10	80.0 - 81.5	16	19- 28- 18	46	--	--
11	90.0 - 91.5	10	13- 20- 22	42	--	--
12	100.0 - 101.5	16	19- 24- 30	54	--	--
13	110.0 - 111.5	10	19- 39- 42	81	--	--
14	120.0 - 121.5	13	14- 42- 45	97	--	--

*Sum of hammer drops in last 12 inches.

†Unconfined compression strength measurement made with pocket penetrometer.

SIEVE AND HYDROMETER ANALYSES OF SPLIT-SPOON SAMPLES (in percent)

Sample	Distribution of all parts		Distribution of part < 2.0 mm		
	> 2.0 mm	< 2.0 mm	.062-2.0 mm	.004-.062 mm	< .004 mm
	Gravel	Sand, silt, clay	Sand	Silt	Clay
1 (lower 0.75 ft)	22	78	32	52	16
2	11	89	36	48	16
3	12	88	44	41	15
4 (upper 0.5 ft)	12	88	50	36	14
5	2	98	35	39	26

KNE 38N6E-23.3h - Concluded

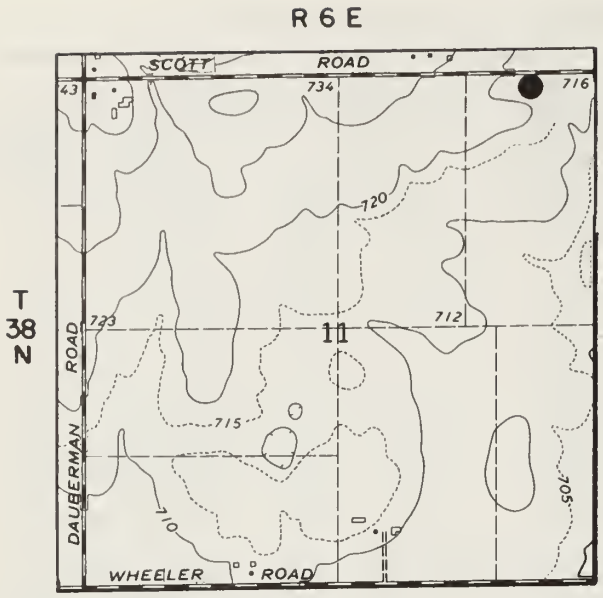
SIEVE ANALYSES OF SPLIT-SPOON SAMPLES (in cumulative percent)

Sample no. and depth (ft)	Tyler screen number											
	4	9	16	24	32	42	60	80	115	170	250	Pan
	Gravel		Sand									Silt, clay
[6]40.0 - 41.5	17.9	36.5	52.3	60.6	63.1	75.1	84.1	87.8	90.4	92.4	93.2	100.0
[7]50.0 - 51.5	30.5	50.1	60.0	65.3	70.6	78.5	85.0	88.0	90.6	92.6	93.7	100.0
[8]60.0 - 61.5	9.4	23.3	30.3	33.9	39.7	62.5	86.4	93.0	95.7	97.0	97.6	100.0
[10]80.0 - 81.5	15.7	26.5	36.9	43.4	51.6	67.8	80.6	85.7	89.0	91.6	93.2	100.0
[11]90.0 - 91.5	1.3	6.7	17.8	30.5	47.6	65.9	74.6	78.9	83.2	86.0	90.4	100.0
[12]100.0-101.5	34.9	50.3	63.0	71.0	78.4	93.1	97.3	98.7	99.3	99.5	99.6	100.0
[13]110.0-111.5	6.0	10.7	14.9	20.1	35.2	65.7	81.1	87.2	90.6	92.6	93.7	100.0
[14]120.0-121.5	32.4	51.4	64.3	70.3	75.2	80.1	83.7	86.2	88.6	90.5	91.7	100.0

SIEVE ANALYSES OF ROTARY SAMPLES (in cumulative percent)

Sample depth (ft)	Tyler screen number											
	4	9	16	24	32	42	60	80	115	170	250	Pan
	Gravel		Sand									Silt, clay
50.0- 55.0	26.4	63.8	80.0	85.5	90.2	94.5	97.3	98.5	99.1	99.4	99.6	100.0
60.0- 65.0	3.0	35.7	63.8	73.8	81.1	90.1	95.6	97.4	98.4	98.9	99.1	100.0
70.0- 75.0	42.1	65.3	78.0	84.1	89.3	94.2	97.3	98.6	99.3	99.6	99.7	100.0
80.0- 85.0	22.8	51.1	72.4	80.8	86.5	92.6	96.3	98.0	98.8	99.2	99.4	100.0
90.0- 95.0	61.2	75.4	84.5	88.6	92.6	96.1	98.1	98.8	99.2	99.3	99.4	100.0
100.0-105.0	33.3	56.3	71.2	78.3	85.4	92.1	96.6	98.2	98.9	99.3	99.5	100.0
110.0-115.0	31.8	53.3	63.3	69.8	78.6	89.5	95.9	98.2	99.1	99.4	99.5	100.0
120.0-125.0	26.5	59.7	74.2	78.8	84.3	91.0	95.8	97.8	98.8	99.2	99.4	100.0

DRILLING RECORD FOR KNE 38N6E-11.1h



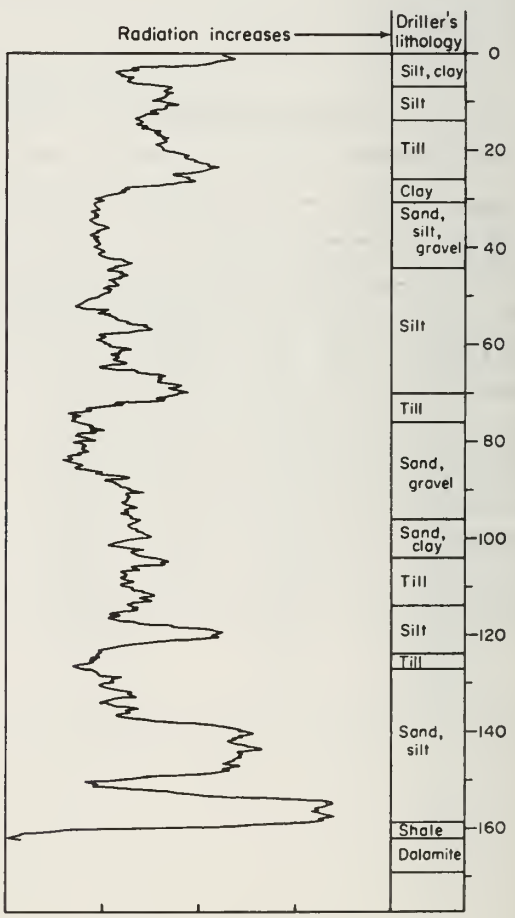
Location of test:

N 5,250 ft, W 650 ft from SE cor. of sec. 11, S 30 ft of the center line and W 650 ft of a 24-in. metal culvert pipe under Scott Road (Big Rock Quadrangle, 1968)

Surface elevation: 718 ft
Date started: 6-21-72
Date completed: 6-23-72
Electric log interval: 0-163.0 ft
Natural gamma log interval: 0-162.0 ft

Remarks: Flow of 0.5 gpm (gallons per minute) developed overnight from the mud-filled borehole 150.0 ft deep.

GAMMA-RAY LOG WITH DRILLER'S LITHOLOGY



KNE 38N6E-11.1h - Continued

DESCRIPTION OF MATERIALS

Description	Thickness (ft)	Depth (ft)
Topsoil, black	1.5	0.0 - 1.5
Silt, gray, sandy, boulders	1.5	1.5 - 3.0
Clay, brown and gray, sandy, sand and gravel seams	2.0	3.0 - 5.0
Sand and gravel, brown	2.0	5.0 - 7.0
Silt, gray, clayey	7.0	7.0 - 14.0
Sand and gravel, gray	1.0	14.0 - 15.0
Till, predominantly clay, gray, pink cast, sandy, gravelly	11.0	15.0 - 26.0
Clay, gray, silty	4.5	26.0 - 30.5
Sand, brown, silty, loosely packed	3.5	30.5 - 34.0
Silt, brown, clayey	3.0	34.0 - 37.0
Sand and gravel, brown, clay layers	7.0	37.0 - 44.0
Silt, gray, sand and gravel layers	13.0	44.0 - 57.0
Silt, gray, clayey, sandy	13.0	57.0 - 70.0
Till, predominantly clay, gray, sandy, silty, gravelly	6.0	70.0 - 76.0
Sand and gravel, brown	20.0	76.0 - 96.0
Clay, gray, sandy	2.0	96.0 - 98.0
Sand, brown, silty	6.0	98.0 104.0
Till, predominantly clay, gray, sandy, gravelly, sand layers	10.0	104.0 - 114.0
Silt, gray, hard	10.0	114.0 - 124.0
Till, predominantly clay, gray, sandy, gravelly	3.0	124.0 - 127.0
Sand, gray, silty, hard	11.0	127.0 - 138.0
Silt, gray, clayey, hard	14.0	138.0 - 152.0
Sand, gray	7.0	152.0 - 159.0
Shale, gray	3.0	159.0 - 162.0
Dolomite, gray	7.0	162.0 - 169.0

Total depth 169.0 ft

KNE 38N6E-11.1h - Continued

SPLIT-SPOON SAMPLES

Sample	Depth (ft)	Recovery (in.)	Blows/6-inch hammer drop	N value*	Qp† (tons/ft^2)	Moisture content (%)
1	1.0 - 2.5	9	2- 2- 4	6	1.5	26.2
2	3.0 - 4.5	18	3- 4- 4	8	1.0	15.7
3	5.0 - 6.5	15	5- 9- 11	20	4.0	15.2
4	10.0 - 11.5	12	8- 13- 16	29	4.5+	14.7
5	20.0 - 21.5	18	5- 6- 7	13	0.8	11.1
6	30.0 - 31.5	15	5- 9- 9	18	--	24.7
7	40.0 - 41.5	18	5- 10- 13	23	--	19.4
8	50.0 - 51.5	15	17- 24- 27	51	--	24.4
9	60.0 - 61.5	18	21- 41- 32	73	4.5+	9.4
10	70.0 - 71.5	13	10- 21- 34	55	3.8	12.1
11	80.0 - 81.5	18	31- 55- 74	129	--	--
12	90.0 - 91.5	18	45- 55- 50	105	--	15.8
13	105.0 - 106.5	18	16- 23- 41	64	2.8	10.4
14	110.0 - 111.5	11	11- 20- 21	41	3.5	8.2
15	120.0 - 121.5	16	14- 29- 39	68	4.5+	15.0
16	130.0 - 131.5	17	44- 70- 81	151	--	--
17	140.0 - 141.5	14	21- 39- 48	87	4.5+	13.5
18	150.0 - 151.5	18	38- 42- 61	103	4.5+	13.4
19	160.0 - 160.5	3	131 (6-in. total drop)		--	10.0

*Sum of hammer drops in last 12 inches.

†Unconfined compressive strength measurement made with pocket penetrometer.

SIEVE AND HYDROMETER ANALYSES OF SPLIT-SPOON SAMPLES (in percent)

Sample	Distribution of all parts		Distribution of part < 2.0 mm		
	> 2.0 mm	< 2.0 mm	.062-2.0 mm	.004-.062 mm	< .004 mm
	Gravel	Sand, silt, clay	Sand	Silt	Clay
2	5	95	40	49	11
3	6	94	16	69	15
4	3	97	18	63	19
5	4	96	29	42	29
9	8	92	53	33	14
10	1	99	12	82	6
12	7	93	38	30	32
13	9	91	40	39	21
14	12	88	48	36	16
15	0	100	6	62	32
17	0	100	3	65	32
18	0	100	5	66	29

KNE 38N6E-11.1h - Concluded

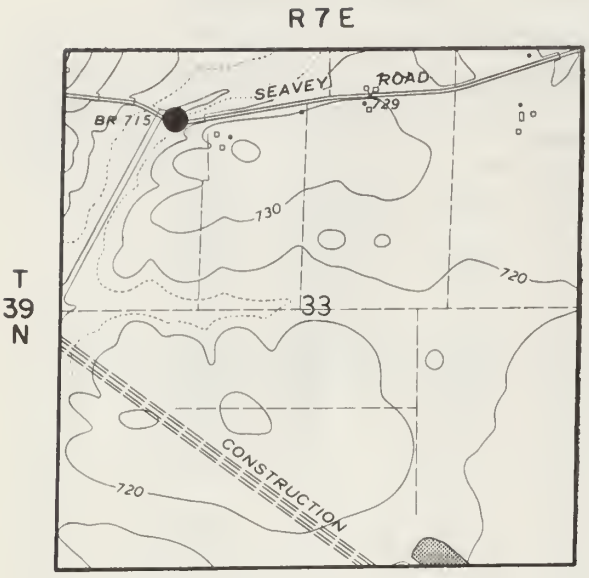
SIEVE ANALYSES OF SPLIT-SPOON SAMPLES (in cumulative percent)

Sample no. and depth (ft)	Tyler screen number											
	4	9	16	24	32	42	60	80	115	170	250	Pan
	Gravel		Sand									Silt, clay
^{7}40.0 - 41.5	0.9	1.5	3.1	3.5	3.9	11.4	54.6	80.4	89.7	92.6	94.2	100.0
^{11}60.0 - 61.5	6.0	15.9	23.4	27.5	31.8	40.2	51.7	62.0	74.5	84.3	90.0	100.0
^{12}80.0 - 81.5	1.4	3.9	7.6	11.0	20.4	43.6	70.3	83.7	86.4	88.1	94.4	100.0
^{16}130.0-131.5	0.0	0.8	1.6	3.1	6.0	12.9	31.5	66.1	83.9	90.5	93.4	100.0

SIEVE ANALYSES OF ROTARY SAMPLES (in cumulative percent)

Sample depth (ft)	Tyler screen number											
	4	9	16	24	32	42	60	80	115	170	250	Pan
	Gravel		Sand									Silt, clay
40.0- 45.0	0.8	4.0	4.8	8.8	19.0	33.8	62.3	79.3	88.9	93.3	95.1	100.0
80.0- 85.0	1.7	6.1	15.7	19.6	27.9	43.4	70.4	84.5	92.9	96.5	97.7	100.0
90.0- 95.0	0.1	4.6	11.0	15.6	28.0	46.5	74.3	87.4	93.8	96.5	97.5	100.0
130.0-135.0	0.3	11.4	18.6	22.5	31.4	45.3	71.2	85.9	93.4	96.2	97.4	100.0
150.0-155.0	0.0	7.1	16.8	19.5	24.8	35.2	58.1	75.1	86.0	91.4	94.3	100.0

DRILLING RECORD FOR KNE 39N7E-33.7g



Location of test:

N 4,600 ft, W 4,100 ft from SE cor. of sec. 33, N 20 ft of the center line of Seavey Road and E 290 ft of the center of a concrete bridge along Seavey Road (Sugar Grove Quadrangle, 1964)

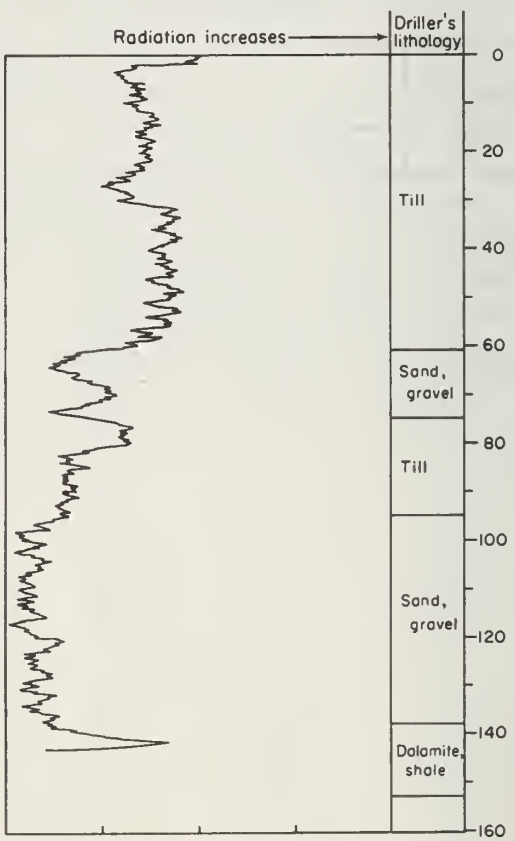
Surface elevation: 715 ft
Date started: 6-26-72
Date completed: 6-28-72
Electric log interval: 0-142.0 ft
Natural gamma log interval: 0-143.0 ft

Zones of fluid loss:

61.0-67.0 ft
- Density: 10.2 lb/gal
- Viscosity: 44 sec/qt
- Loss: 120 gal

115.0-121.0 ft
- Density: 9.8 lb/gal
- Viscosity: 75 sec/qt
- Loss: 65 gal

GAMMA-RAY LOG WITH DRILLER'S LITHOLOGY



KNE 39N7E-33.7g - Continued

DESCRIPTION OF MATERIALS

Description	Thickness (ft)	Depth (ft)
Topsoil, black	1.0	0.0 - 1.0
Till, predominantly clay, brown, sandy, silty, gravelly	2.5	1.0 - 3.5
Till, predominantly clay, gray, pink cast, sandy, gravelly	2.5	3.5 - 6.0
Till, predominantly clay, gray, sandy, gravelly, sand and gravel layers	24.0	6.0 - 30.0
Till, predominantly clay, gray, sandy, gravelly, hard	31.0	30.0 - 61.0
Sand and gravel, gray	6.0	61.0 - 67.0
Sand and gravel, gray, clay layers	7.5	67.0 - 74.5
Till, predominantly clay, gray, sandy, gravelly, very hard	9.5	74.5 - 84.0
Till, predominantly clay, gray, sandy, gravelly	11.0	84.0 - 95.0
Sand and gravel, brown, boulders	43.0	95.0 - 138.0
Dolomite, gray	3.0	138.0 - 141.0
Dolomite and shale, green	12.0	141.0 - 153.0
		Total depth 153.0 ft

SPLIT-SPOON SAMPLES

Sample	Depth (ft)	Recovery (in.)	Blows/6-inch hammer drop*	N value†	Qp‡ (tons/ft^2)	Moisture content (%)
1	1.0 - 2.5	9	3- 4- 6	10	1.8	29.0
2	5.0 - 6.5	16	7- 4- 4	8	1.5	13.2
3	10.0 - 11.5	11	3- 5- 7	12	2.0	12.7
4	20.0 - 21.5	16	8- 26- 38	64	4.5+	8.3
5	30.0 - 31.5	16	22- 27- 22	49	4.5+	8.2
6	40.0 - 41.5	18	20- 36- 51	87	4.5+	9.0
7	50.0 - 51.5	18	15- 28- 40	68	4.5+	10.5
8	60.0 - 61.5	10	4- 5- 7	12	3.3	12.8
9	70.0 - 71.5	14	14- 15- 18	33	--	12.1
10	80.0 - 80.8	8	66-100 (10-in. total drop)		4.5+	11.7
11	90.0 - 91.5	8	32- 53-103	156	4.5+	11.7
12	97.0 - 97.5	6	150- 31	--	--	11.6
13	110.0 - 111.5	4	51-109-162	271	--	12.1
14	115.0 - 115.6	7	170- 50 (7-in. total drop)		--	13.4
15	121.0 - 122.5	11	22- 48- 55	103	--	--
16	130.0 - 131.5	16	66-159-124	283	--	12.2

* Sample 12 (last 6 inches) and sample 14 (last 7 inches) - 300 lb hammer.

† Sum of hammer drops in last 12 inches.

‡ Unconfined compressive strength measurement made with pocket penetrometer.

KNE 39N7E-33.7g - Concluded

SIEVE AND HYDROMETER ANALYSES OF SPLIT-SPOON SAMPLES (in percent)

Sample	Distribution of all parts		Distribution of part < 2.0 mm		
	> 2.0 mm	< 2.0 mm	.062-2.0 mm	.004-.062 mm	< .004 mm
	Gravel	Sand, silt, clay	Sand	Silt	Clay
2	6	94	25	44	31
3	4	96	33	37	30
4	7	93	42	33	25
5	4	96	31	38	31
6	0	100	8	72	20
7	3	97	27	45	28
8	3	97	26	42	32
10	15	85	33	43	24
11	12	88	36	43	21

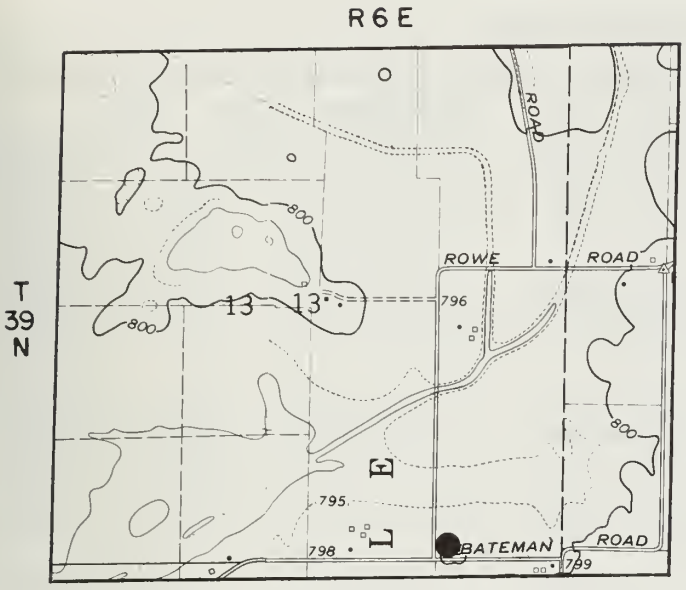
SIEVE ANALYSES OF SPLIT-SPOON SAMPLES (in cumulative percent)

Sample no. and depth (ft)	Tyler screen number											
	4	9	16	24	32	42	60	80	115	170	250	Pan
	Gravel		Sand									Silt, clay
[8]60.0 - 61.5	5.4	13.0	23.0	30.6	39.1	53.2	70.3	81.1	89.8	94.2	95.9	100.0
[9]70.0 - 71.5	28.1	51.8	68.8	75.8	80.2	83.8	86.3	88.1	90.2	92.0	93.0	100.0
[15]121.0-122.5	11.0	28.4	43.8	53.1	62.9	74.0	81.3	84.9	88.4	90.0	92.2	100.0
[16]130.0-131.5	31.3	50.9	66.1	73.0	77.6	81.5	84.1	86.0	88.2	90.1	91.3	100.0

SIEVE ANALYSES OF ROTARY SAMPLES (in cumulative percent)

Sample depth (ft)	Tyler screen number											
	4	9	16	24	32	42	60	80	115	170	250	Pan
	Gravel		Sand									Silt, clay
60.0- 65.0	28.6	60.9	82.6	88.1	93.1	96.2	98.0	98.7	99.1	99.3	99.4	100.0
70.0- 75.0	31.8	77.3	89.5	91.8	93.9	95.4	96.6	97.3	97.8	98.2	98.5	100.0
90.0- 95.0	78.0	89.1	93.5	95.5	97.2	98.7	99.2	99.5	99.6	99.7	99.8	100.0
110.0-115.0	43.0	77.5	92.2	94.6	96.4	97.5	98.5	99.0	99.3	99.4	99.5	100.0
120.0-125.0	51.8	82.9	92.8	95.0	96.8	97.9	98.9	99.3	99.5	99.6	99.7	100.0
130.0-135.0	24.7	51.1	75.6	84.7	92.7	96.5	98.5	99.1	99.4	99.5	99.6	100.0

DRILLING RECORD FOR KNE 39N6E-13.3a



Location of text:

N 75 ft, W 1,340 ft from SE cor. of sec. 13, N 75 ft and E 20 ft of intersection of center lines of Bateman and Rowe Roads (Sugar Grove Quadrangle, 1964)

Surface elevation: 798 ft
Date started: 6-15-72
Date completed: 6-19-72
Electric log interval: 0-142.0 ft
Natural gamma log interval: 0-142.0 ft

Zones of fluid loss:

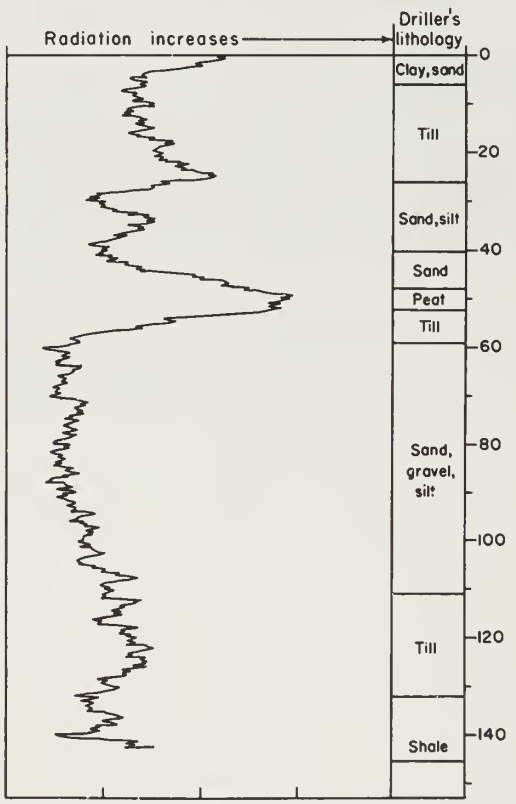
59.0-66.0 ft
- Density: 9.8 lb/gal
- Viscosity: 40 sec/qt
- Loss: 570 gal

66.0-70.0 ft
- Density: 9.8 lb/gal
- Viscosity: 42 sec/qt
- Loss: 90 gal

70.0-74.0 ft
- Density: 9.8 lb/gal
- Viscosity: 42 sec/qt
- Loss: 30 gal

74.0-93.0 ft
- Density: 9.8 lb/gal
- Viscosity: 42 sec/qt
- Loss: 285 gal

GAMMA-RAY LOG WITH DRILLER'S LITHOLOGY



KNE 39N6E-13.3a - Continued

DESCRIPTION OF MATERIALS

Description	Thickness (ft)	Depth (ft)
Topsoil, black	1.0	0.0 - 1.0
Clay, brown, sandy	3.0	1.0 - 4.0
Sand, brown, silty	2.0	4.0 - 6.0
Till, predominantly clay, brown, silty, gravelly	20.0	6.0 - 26.0
Silt, gray, clayey	3.0	26.0 - 29.0
Sand, brown	4.0	29.0 - 33.0
Silt, gray, sandy, soft	3.0	33.0 - 36.0
Sand, gray, silty, gravelly	4.0	36.0 - 40.0
Till, predominantly clay, gray, gravelly	2.0	40.0 - 42.0
Sand, gray, clay layers	5.5	42.0 - 47.5
Peat	4.0	47.5 - 51.5
Clay, gray, organic material, hard	3.5	51.5 - 54.0
Till, predominantly clay, gray, sandy, gravelly	5.0	54.0 - 59.0
Sand and gravel, gray, boulders	7.0	59.0 - 66.0
Silt, gray, sandy, gravelly	8.0	66.0 - 74.0
Sand and gravel, gray	32.0	74.0 - 106.0
Silt, gray, clayey	3.0	106.0 - 109.0
Sand and gravel, brown	2.0	109.0 - 111.0
Till, predominantly clay, gray, sandy, silty, gravelly	15.0	111.0 - 126.0
Till, predominantly clay, gray, sandy, silty, gravelly, sand and gravel layers	6.0	126.0 - 132.0
Shale, green, silty; dolomite, gray, broken	3.0	132.0 - 135.0
Shale, green, silty; dolomite, gray	10.0	135.0 - 145.0
	Total depth 145.0 ft	

KNE 39N6E-13.3a - Continued

SPLIT-SPOON SAMPLES

Sample	Depth (ft)	Recovery (in.)	Blows/6-inch hammer drop	N value*	Qp† (tons/ft^2)	Moisture content (%)
1	1.0 - 2.5	14	2- 2- 4	6	1.0[1]	28.4[2]
2	3.0 - 4.5	14	2- 3- 5	8	--	23.2
3	10.0 - 11.5	18	5- 7- 9	16	1.5	11.4
4	20.0 - 21.5	18	3- 7- 9	16	1.3	10.9
5	30.0 - 31.5	15	8- 16- 17	32	--	20.2
6	35.0 - 36.5	18	9- 12- 14	26	--	20.1
7	36.5 - 38.0	15	8- 12- 16	28	--	18.3
8	38.0 - 39.5	13	8- 14- 35	49	--	19.6
9	39.5 - 41.0	9	28- 33- 19	52	4.5+	9.3
10	41.0 - 42.5	9	5- 3- 29	32	2.5	12.8
11	42.5 - 44.0	10	17- 37- 41	78	--	24.4
12	44.0 - 45.5	9	6- 35- 44	79	--	15.6
13	48.0 - 49.5	18	4- 6- 9	15	2.3[3]	47.6[4]
14	49.5 - 51.0	15	10- 16- 23	39	2.0	21.6
15	51.0 - 52.5	18	13- 20- 29	49	4.5+	15.2
16	61.0 - 62.5	15	76- 55- 59	114	--	16.0
17	70.0 - 71.5	12	29- 27- 14	41	--	16.3
18	80.0 - 81.5	6	16- 47- 36	83	--	14.0
19	90.0 - 91.5	18	26- 18- 15	33	--	9.6
20	100.0 - 101.5	15	22- 29- 31	60	--	16.9
21	110.0 - 111.0	8	66-109	--	--	14.8
22	120.0 - 121.5	18	12- 13- 19	32	2.0	10.5
23	130.0 - 131.5	15	26- 37- 87	124	4.0	15.0

* Sum of hammer drops in last 12 inches.

† Unconfined compressive strength measurement made with pocket penetrometer.

[1]Lower 9 inches. [2]Lower 9 inches. [3]Upper inch. [4]Lower 14 inches.

KNE 39N6E-13.3a - Continued

SIEVE AND HYDROMETER ANALYSES OF SPLIT-SPOON SAMPLES (in percent)

Sample	Distribution of all parts		Distribution of part < 2.0 mm		
	> 2.0 mm	< 2.0 mm	.062-2.0 mm	.004-.062 mm	< .004 mm
	Gravel	Sand, silt, clay	Sand	Silt	Clay
1[1]	0	100	7	52	41
2	0	100	72	22	6
3	8	92	45	42	13
4	7	93	33	49	18
5	0	100	66	23	11
6	0	100	48	42	10
7	0	100	71	21	8
8	0	100	58	34	8
9	21	79	45	33	22
10	23	67	55	20	25
11	1	99	67	27	6
12	1	99	44	43	13
13[2]	0	100	8	56	36
13[3]	0	100	8	63	29
14	0	94	6	67	27
15	0	100	8	54	38
16	22	78	79	12	9
17	18	72	60	25	15
18	19	71	67	20	13

[1]Lower 9 in. [2]Upper 4 in. [3]Lower 14 in.

SIEVE ANALYSES OF SPLIT-SPOON SAMPLES (in cumulative percent)

Sample no. and depth (ft)	Tyler screen number											
	4	9	16	24	32	42	60	80	115	170	250	Pan
	Gravel		Sand									Silt, clay
[2]3.0 - 4.5	0.0	0.1	0.2	0.3	0.7	1.5	5.7	27.1	64.2	85.3	90.8	100.0
[5]30.0 - 31.5	0.0	0.5	0.9	1.4	1.8	2.4	4.6	12.9	42.5	70.5	82.4	100.0
[10]41.0 - 42.5	1.6	3.8	6.5	9.0	14.4	31.1	58.9	78.8	91.0	94.9	96.0	100.0
[11]42.5 - 44.0	0.0	0.0	0.0	0.2	0.5	1.2	3.4	12.7	46.5	69.5	78.8	100.0
[20*]100.0-101.5	2.3	5.8	10.2	13.2	18.0	33.6	60.1	73.2	82.9	87.8	89.4	100.0
[23]130.0-131.5	0.1	0.8	2.6	7.3	18.0	41.4	67.7	81.4	89.0	92.5	93.8	100.0

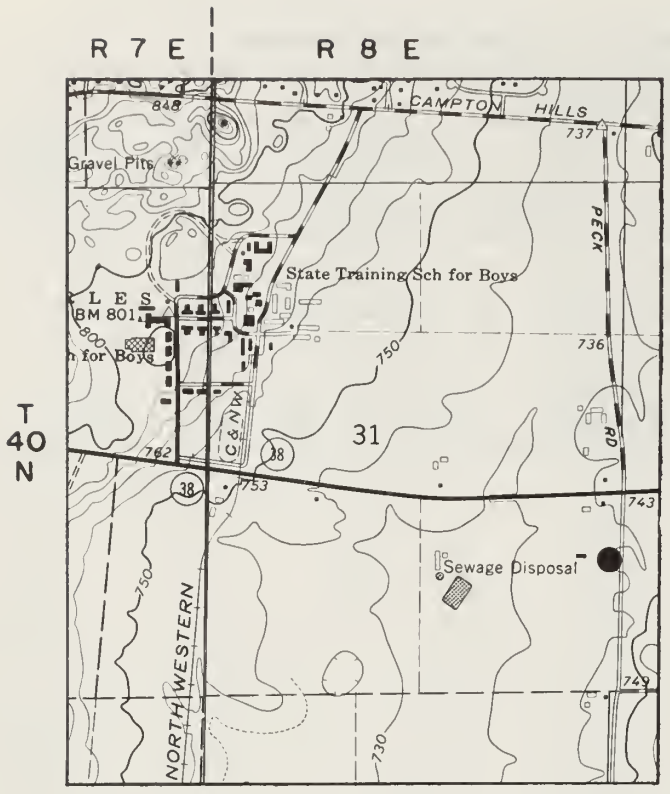
* Lower 0.6 foot of interval only.

KNE 39N6E-13.3a - Concluded

SIEVE ANALYSES OF ROTARY SAMPLES (in cumulative percent)

Sample depth (ft)	Tyler screen number											
	4	9	16	24	32	42	60	80	115	170	250	Pan
	Gravel		Sand									Silt, clay
35.0- 40.0	1.7	4.7	6.9	7.9	9.1	12.0	23.8	52.3	81.9	92.7	96.6	100.0
60.0- 65.0	7.6	45.4	71.5	79.2	84.8	89.5	92.3	94.4	96.8	95.0	98.5	100.0
70.0- 75.0	21.5	37.8	60.0	71.7	80.2	88.1	92.3	94.3	96.1	97.2	97.8	100.0
80.0- 85.0	61.5	77.9	87.4	91.6	95.2	97.5	98.3	98.7	99.0	99.2	99.4	100.0
90.0- 95.0	78.0	89.1	93.5	95.5	97.2	98.7	99.2	99.5	99.6	99.7	99.8	100.0
100.0-105.0	9.6	17.2	26.3	35.7	48.7	70.0	88.1	94.7	97.6	98.7	99.1	100.0

DRILLING RECORD FOR KNE 40N8E-31.1b

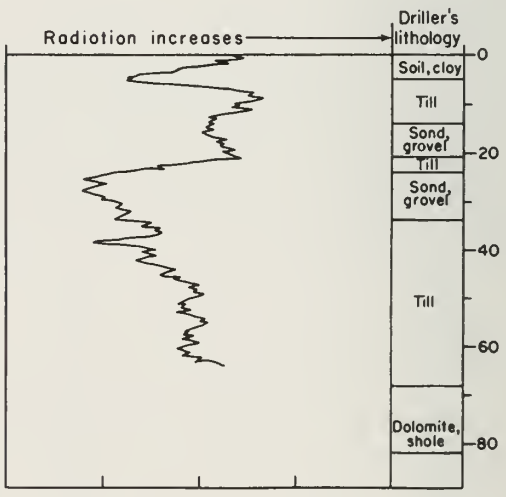


Location of test:
N 1,300 ft, W 15 ft from SE cor. of sec. 31, S 100 ft from a 24-in. metal culvert pipe under Peck Road and W 15 ft of the center line of Peck Road (Geneva Quadrangle, 1964)

Surface elevation: 742 ft
Date started: 6-18-72
Date completed: 6-13-72
Electric log interval: 0-66.0 ft
Natural gamma log interval: 0-64.0 ft

Zones of fluid loss:
68.0-82.0 ft
Density: 9.8 lb/gal
Viscosity: 41 sec/qt
Loss: 260 gal

GAMMA-RAY LOG WITH DRILLER'S LITHOLOGY



KNE 40N8E-31.1b - Continued

DESCRIPTION OF MATERIALS

Description	Thickness (ft)	Depth (ft)
Topsoil, black	1.5	0.0 - 1.5
Clay, brown, sandy	3.5	1.5 - 5.0
Till, predominantly clay, gray, sandy, gravelly	8.0	5.0 - 13.0
Clay, gray, sandy	1.0	13.0 - 14.0
Sand and gravel, brown	7.0	14.0 - 21.0
Till, clay, gray, sandy, gravelly	3.0	21.0 - 24.0
Sand and gravel, gray, clayey	10.0	24.0 - 34.0
Till, predominantly clay, gray, pink cast, sandy, gravelly	15.0	34.0 - 49.0
Till, predominantly clay, gray, sandy, gravelly, hard.	19.0	49.0 - 68.0
Dolomite, brown; shale, green; clay, white	14.0	68.0 - 82.0
	Total depth	82.0 ft

SPLIT-SPOON SAMPLES

Sample	Depth (ft)	Recovery (in.)	Blows/6-inch hammer drop	N value*	Qp† (tons/ft^2)	Moisture content (%)
1	1.0 - 2.5	9	2- 4- 7	11	4.3	20.5
2	3.0 - 4.5	15	3- 4- 6	10	1.5	28.2
3	10.0 - 11.5	18	4- 7- 8	15	2.5	14.9
4	20.0 - 21.5	14	6- 8- 11	19	1.0	16.0‡
5	30.0 - 31.5	6	6- 11- 24	35	--	--
6	40.0 - 41.5	6	4- 6- 70	76	4.5+	10.9
7	50.0 - 51.5	8	14- 21- 52	73	4.5+	11.1
8	60.0 - 61.5	12	22- 31- 46	77	4.5+	10.9
9	70.0 - 71.5	15	47- 76- 81	157	4.5+	19.3

*Sum of hammer drops in last 12 inches.

†Unconfined compressive strength measurement made with pocket penetrometer.

‡For interval 20.0 - 20.4 ft only.

KNE 40N8E-31.1b - Concluded

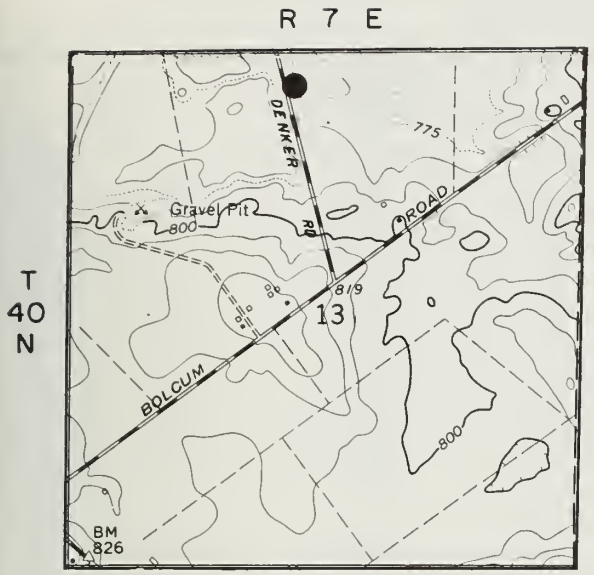
SIEVE AND HYDROMETER ANALYSES OF SPLIT-SPOON SAMPLES (in percent)

Sample	Distribution of all parts		Distribution of part < 2.0 mm		
	> 2.0 mm	< 2.0 mm	.062-2.0 mm	.004-.062 mm	< .004 mm
	Gravel	Sand, silt, clay	Sand	Silt	Clay
2	0	100	0	56	44
3	6	94	24	46	30
4	10	90	27	40	33
6	14	86	48	33	19
7	4	96	26	40	34
8	2	98	25	41	34

SIEVE ANALYSES OF ROTARY SAMPLES (in cumulative percent)

Sample depth (ft)	Tyler screen number											
	4	9	16	24	32	42	60	80	115	170	250	Pan
	Gravel		Sand									Silt, clay
15.0-20.0	0.6	25.5	60.6	76.4	85.9	91.8	94.7	96.0	97.0	97.5	97.8	100.0

DRILLING RECORD FOR KNE 40N7E-13.5h

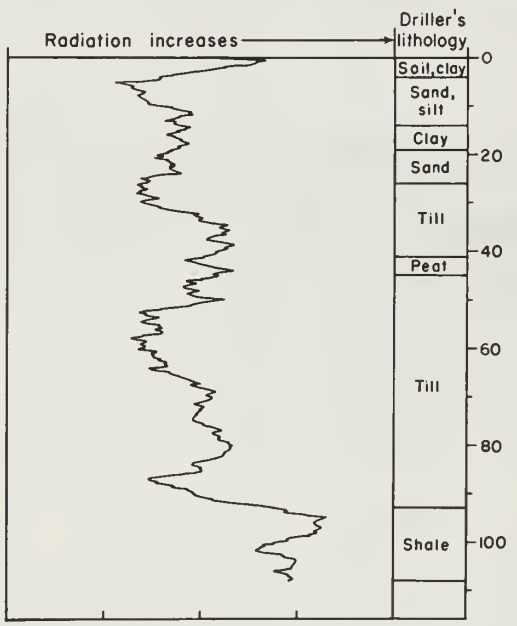


Location of test:

N 5,000 ft, W 3,000 ft from SE cor. of sec. 13, S 200 ft along Denker Road from a field-stone corner post and E 20 ft of the center line of Denker Road (Elburn Quadrangle, 1964)

Surface elevation: 785 ft
Date started: 6-2-72
Date completed: 6-6-72
Electric log interval: 0-105.0 ft
Natural gamma log interval: 0-106.0 ft

GAMMA-RAY LOG WITH DRILLER'S LITHOLOGY



KNE 40N7E-13.5h - Continued

DESCRIPTION OF MATERIALS

Description	Thickness (ft)	Depth (ft)
Topsoil, black	0.5	0.0 - 0.5
Clay, brown and gray	3.5	0.5 - 4.0
Sand, brown, silty	5.5	4.0 - 9.5
Silt, gray	4.5	9.5 - 14.0
Clay, gray, silty	5.0	14.0 - 19.0
Sand, gray, silty, clay layers	3.0	19.0 - 22.0
Sand and gravel, gray	4.0	22.0 - 26.0
Till, predominantly clay, gray, sandy, gravelly	15.0	26.0 - 41.0
Peat	3.5	41.0 - 44.5
Till, predominantly clay, gray, sandy, gravelly, boulders	25.5	44.5 - 70.0
Till, predominantly clay, gray, sandy, gravelly, boulders and sand and gravel layers	23.0	70.0 - 93.0
Shale, gray and green	15.0	93.0 - 108.0
	Total depth 108.0 ft	

SPLIT-SPOON SAMPLES

Sample	Depth (ft)	Recovery (in.)	Blows/6-inch hammer drop	N value*	Qp† (tons/ft^2)	Moisture content (%)
1	1.0 - 2.5	6	2- 4- 5	9	1.0	15.5
2	3.0 - 4.5	15	4- 6- 9	15	3.5	19.3
3	10.0 - 11.5	18	4- 5- 4	9	1.0	19.8
4	20.0 - 21.5	12	12- 15- 13	28	--	--
5	30.0 - 31.5	14	3- 6- 6	12	--	8.64
6	40.0 - 41.5	18	12- 17- 23	40	4.0	--
7	41.5 - 43.0	18	11- 26- 47	73	3.8	--
8	50.0 - 51.5	14	11- 15- 23	38	4.5+	13.1
9	60.0 - 61.5	15	23- 38- 35	73	4.5+	7.4
10	80.0 - 81.5	18	16- 24- 37	61	4.5+	10.2
11	90.0 - 91.0	12	37-108 (12-in. total drop)		4.5+	7.1
12	95.0 - 96.5	18	23- 38- 76	114	4.5+	14.6

* Sum of hammer drops in last 12 inches.

† Unconfined compressive strength measurement made with pocket penetrometer.

KNE 40N7E-13.5h - Concluded

SIEVE AND HYDROMETER ANALYSES OF SPLIT-SPOON SAMPLES (in percent)

Sample	Distribution of all parts		Distribution of part < 2.0 mm		
	> 2.0 mm	< 2.0 mm	.062-2.0 mm	.004-.062 mm	< .004 mm
	Gravel	Sand, silt, clay	Sand	Silt	Clay
1	1	99	11	61	28
2	0	100	8	63	29
3	0	100	22	61	17
4	0	100	12	78	10
5	11	89	47	33	20
6[1]	3	97	24	40	36
6[2]	0	100	3	55	42
7[3]	1	99	15	53	32
8	2	98	12	49	39
9	8	92	50	28	22
10	7	93	25	45	30
11	7	93	37	35	28

[1] Interval 40.0 - 40.3 ft. [2] Interval 40.3 - 41.2 ft. [3] Interval 41.5 - 41.9 ft.

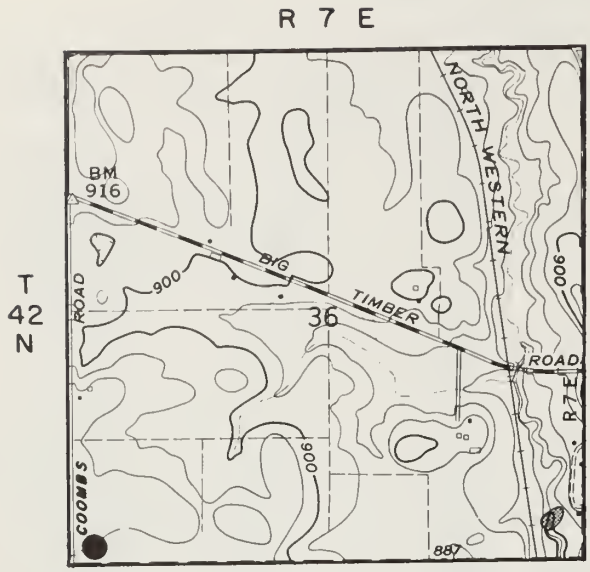
SIEVE ANALYSES OF SPLIT-SPOON SAMPLES (in cumulative percent)

Sample no. and depth (ft)	Tyler screen number											
	4	9	16	24	32	42	60	80	115	170	250	Pan
	Gravel		Sand									Silt, clay
[2]3.0 - 4.5	0.0	0.0	0.0	0.0	0.6	1.2	3.4	12.6	37.4	56.8	65.7	100.0
[4]20.0-21.5	0.0	0.6	1.2	1.7	2.0	2.3	4.8	13.6	37.6	55.4	60.8	100.0

SIEVE ANALYSES OF ROTARY SAMPLES (in cumulative percent)

Sample depth (ft)	Tyler screen number											
	4	9	16	24	32	42	60	80	115	170	250	Pan
	Gravel		Sand									Silt, clay
20.0-25.0	6.6	35.7	48.8	53.3	58.7	64.4	71.1	76.8	82.7	87.1	89.9	100.0

DRILLING RECORD FOR KNE 42N7E-36.8a



Location of test:

N 150 ft, E 200 ft from SW cor. of sec. 36, N 150 ft and E 200 ft of the intersection of the center line of Coombs Road east and a lane south (Elgin Quadrangle, 1962)

Surface elevation: 920 ft
Date started: 5-19-72
Date completed: 5-24-72
Electric log interval: 0-253.0 ft
Natural gamma log interval: 0-239.0 ft

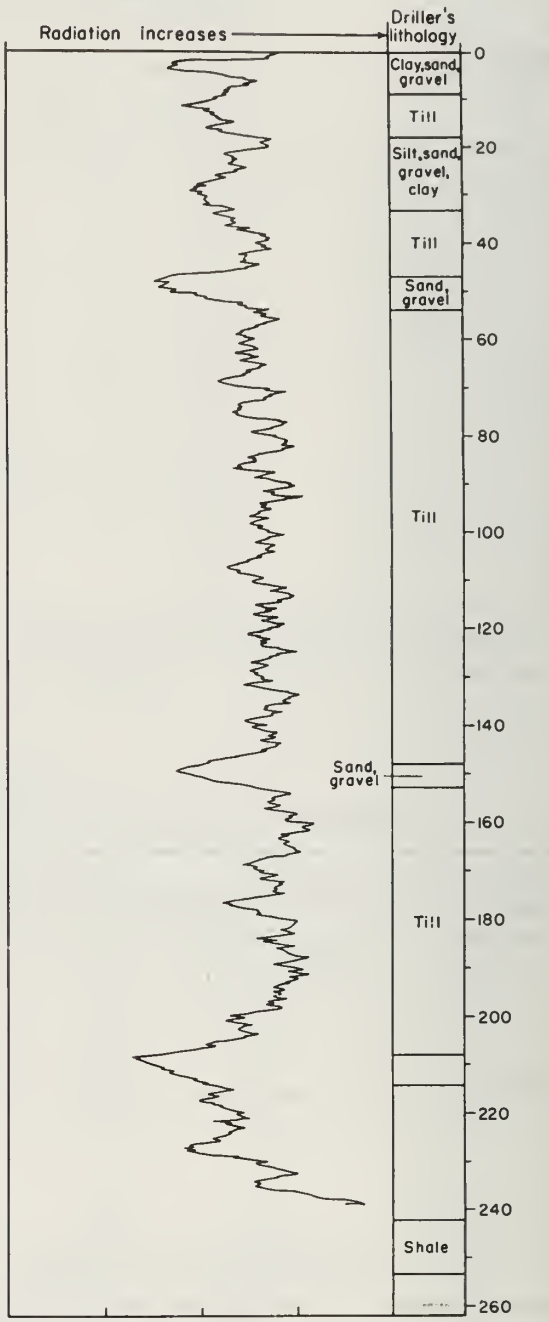
Zones of fluid loss:

4.0-5.5 ft
- Density: 9.6 lb/gal
- Viscosity: 43 sec/qt
- Loss: 20 gal

47.0-54.0 ft
- Density: 9.6 lb/gal
- Viscosity: 44 sec/qt
- Loss: 30 gal

208.0-214.0 ft
- Density: 10.0 lb/gal
- Viscosity: 40 sec/qt
- Loss: 185 gal

GAMMA-RAY LOG WITH DRILLER'S LITHOLOGY



KNE 42N7E-36.8a - Continued

DESCRIPTION OF MATERIALS

Description	Thickness (ft)	Depth (ft)
Topsoil, black	1.5	0.0 - 1.5
Clay, brown and gray, sandy	2.5	1.5 - 4.0
Sand and gravel, brown, silty	1.5	4.0 - 5.5
Clay, gray, silty	3.5	5.5 - 9.0
Till, predominantly clay, gray, sandy, sand and gravel layers	6.0	9.0 - 15.0
Till, predominantly clay, gray, sandy, sand layers	2.5	15.0 - 17.5
Silt, gray, sand layers	7.0	17.5 - 24.5
Sand and gravel	1.0	24.5 - 25.5
Clay, gray, sandy	4.0	25.5 - 29.5
Sand and gravel, gray	3.5	29.5 - 33.0
Till, predominantly clay, gray, sandy, gravelly	14.0	33.0 - 47.0
Sand and gravel, gray	7.0	47.0 - 54.0
Till, predominantly clay, gray, pink cast, sandy, gravelly	16.0	54.0 - 70.0
Till, predominantly clay, gray, pink cast, sandy, gravelly, with boulders and sand layers	78.0	70.0 - 148.0
Sand and gravel, gray, clayey	5.5	148.0 - 153.5
Till, predominantly clay, gray, sandy, gravelly	16.5	153.5 - 170.0
Silt, gray, sandy	4.0	170.0 - 174.0
Till, clay, gray, sandy, gravelly	27.0	174.0 - 201.0
Till, predominantly clay, gray, sandy, silty	7.5	201.0 - 208.5
Gravel and boulders, gray and brown	5.5	208.5 - 214.0
Till, predominantly clay, sandy, silty, gravelly, sand and gravel layers, hard	28.0	214.0 - 242.0
Shale, gray	12.0	242.0 - 254.0
	Total depth 254.0 ft	

KNE 42N7E-36.8a - Continued

SPLIT-SPOON SAMPLES

Sample	Depth (ft)	Recovery (in.)	Blows/6-inch hammer drop*	N value†	Qp‡ (tons/ft^2)	Moisture content (%)
1	1.0 - 2.5	6	3- 4- 5	9	--	--
2	3.0 - 4.5	12	2- 5- 9	14	--	16.7
3	6.0 - 7.5	11	3- 5- 7	12	2.0	15.5
4	9.0 - 10.5	8	6- 14- 20	34	--	--
5	12.0 - 13.5	13	12- 14- 18	32	4.5+	13.4
6	15.0 - 16.5	11	12- 17- 25	42	4.5+	9.1
7	18.0 - 19.5	15	13- 17- 16	33	4.5+	13.5
8	21.0 - 22.5	16	11- 13- 20	33	4.5+	11.1
9	40.0 - 41.5	17	11- 17- 26	42	4.5+	8.5
10	60.0 - 61.5	16	11- 20- 29	49	3.0	10.3
11	80.0 - 81.5	18	11- 23- 31	54	2.8	11.1
12	100.0 - 101.5	18	13- 16- 26	42	1.8	10.7
13	110.0 - 111.5	20	16- 19- 31	50	3.0	10.6
14	115.0 - 116.5	19	11- 19- 23	42	2.5	10.4
15	120.0 - 121.5	18	12- 19- 21	40	2.0	9.5
16	140.0 - 141.5	17	13- 26- 45	71	4.5+	8.9
17	160.0 - 161.5	15	21- 39- 58	97	4.5+	9.0
18	170.0 - 170.5	6	120 (6-in. total drop)		--	--
19	180.0 - 181.5	18	18- 21- 38	59	3.0	10.7
20	190.0 - 191.5	18	13- 22- 32	54	2.5	13.0
21	200.0 - 201.5	17	25- 64-100 (17-in. total drop)		4.5+	9.1
22	220.0 - 221.5	18	29- 52- 51	103	4.5+	14.4
23	230.0 - 230.4	5	104- 52 (5-in. total drop)		4.5+	5.3
24	235.0 - 235.4	5	101 (5-in. total drop)		4.5+	10.1
25	245.0 - 245.3	3	101 (3-in. total drop)		--	--

*Sample 18, sample 23 (last inch), sample 24, and sample 25 - 300 lb hammer.

†Sum of hammer drops in last 12 inches.

‡Unconfined compressive strength measurement made with a pocket penetrometer.

KNE 42N7E-36.8a - Concluded

SIEVE AND HYDROMETER ANALYSES OF SPLIT-SPOON SAMPLES (in percent)

Sample	Distribution of all parts		Distribution of part < 2.0 mm		
	> 2.0 mm	< 2.0 mm	.062-2.0 mm	.004-.062 mm	< .004 mm
	Gravel	Sand, silt, clay	Sand	Silt	Clay
3	0	100	1	61	38
4	5	95	45	44	11
5	10	90	46	37	17
6	9	91	40	39	21
7	0	100	4	61	35
8	0	100	4	65	31
9	7	93	30	36	34
10	3	97	34	33	33
11	6	94	22	44	34
12	3	97	27	38	35
13	4	96	32	32	36
14	6	94	31	33	36
15	5	95	31	34	35
16	4	96	31	37	32
17	4	96	23	40	37
18	0	100	53	37	10
19	4	96	22	37	41
20	4	96	13	45	42
21	7	93	32	24	44
22	6	94	47	31	22
23	8	92	48	29	23
24	22	78	31	39	30

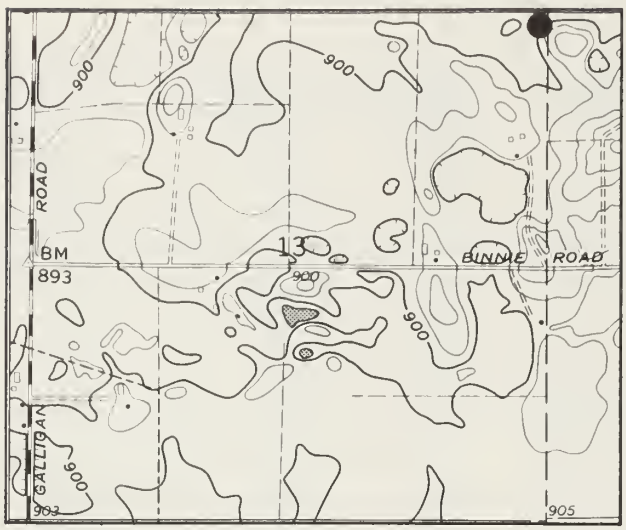
SIEVE ANALYSES OF ROTARY SAMPLES (in cumulative percent)

Sample depth (ft)	Tyler screen number											
	4	9	16	24	32	42	60	80	115	170	250	Pan
	Gravel		Sand									Silt, clay
50.0- 55.0	7.8	55.9	77.0	82.1	86.3	89.5	93.0	94.9	96.3	97.1	97.6	100.0
210.0-215.0	12.6	39.4	59.6	65.1	70.9	76.8	84.5	89.5	93.1	95.1	96.2	100.0

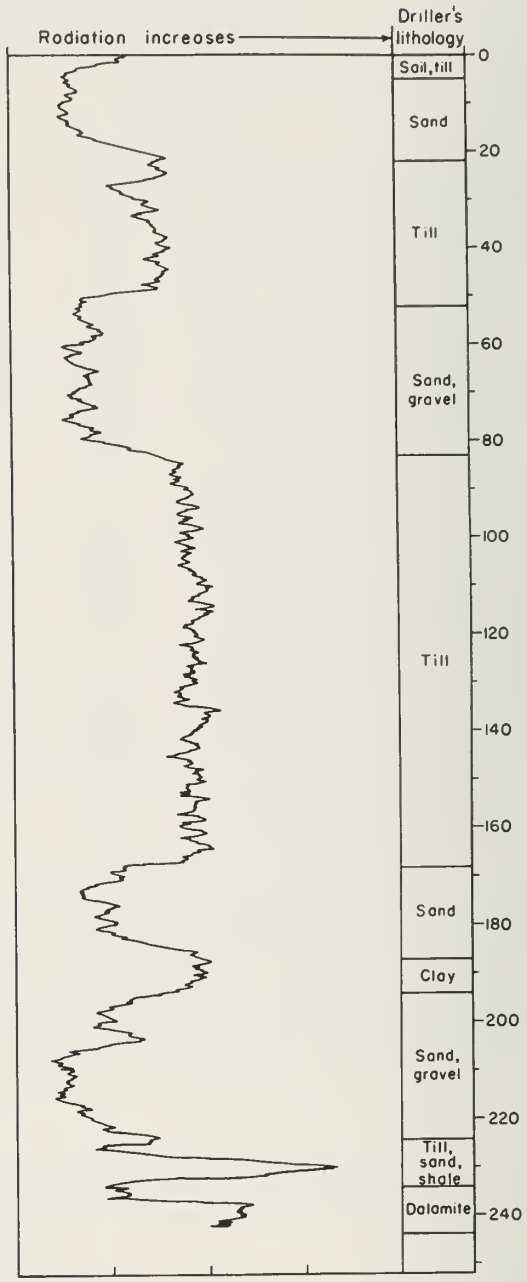
DRILLING RECORD FOR KNE 42N7E-13.1h

R 7 E

T 42 N



GAMMA-RAY LOG WITH DRILLER'S LITHOLOGY



Location of test:
N 5,100 ft, W 75 ft from SE cor. of sec. 13, S 100 ft and W 75 ft of a wooden corner post (Elgin Quadrangle, 1962)

Surface elevation: 900 ft
Date started: 5-26-72
Date completed: 6-1-72
Casing: 8 in. from surface to 21.0 ft
Electric log interval: 0-242.0 ft
Natural gamma log interval: 0-242.0 ft

Zones of fluid loss:

52.0-74.0 ft
- Density: 10.0 lb/gal
- Viscosity: 40 sec/qt
- Loss: 150 gal

74.0-83.0 ft
- Density: 10.0 lb/gal
- Viscosity: 40 sec/qt
- Loss: 90 gal

204.0-218.0 ft
- Density: 10.2 lb/gal
- Viscosity: 38 sec/qt
- Loss: 150 gal

218.0-224.0 ft
- Density: 10.2 lb/gal
- Viscosity: 38 sec/qt
- Loss: 45 gal

225.0-229.0 ft
- Density: 10.2 lb/gal
- Viscosity: 34 sec/qt
- Loss: 15 gal

KNE 42N7E-13.1h - Continued

DESCRIPTION OF MATERIALS

Description	Thickness (ft)	Depth (ft)
Topsoil, black	1.0	0.0 - 1.0
Till, predominantly clay, gray and brown, sandy, gravelly	3.5	1.0 - 4.5
Sand and gravel, brown, plant remains	16.5	4.5 - 21.0
Till, predominantly clay, gray, sandy, silty	31.0	21.0 - 52.0
Sand and gravel, gray, loosely packed	22.0	52.0 - 74.0
Sand and gravel, gray	9.0	74.0 - 83.0
Till, predominantly clay, gray, pink cast, sandy, gravelly	64.0	83.0 - 147.0
Till, predominantly clay, gray, silty, sandy, gravelly	21.0	147.0 - 168.0
Sand, brown	19.0	168.0 - 187.0
Clay, gray, silty, soft	3.0	187.0 - 190.0
Clay, dark gray, silty, trace of wood	4.0	190.0 - 194.0
Sand, brown, silty, clay layers	10.5	194.0 - 204.5
Sand and gravel, brown, boulders	13.5	204.5 - 218.0
Sand and gravel, brown	6.0	218.0 - 224.0
Till, predominantly clay, gray, brown cast, sandy, gravelly	1.5	224.0 - 225.5
Sand and gravel, gray, with boulders	3.5	225.5 - 229.0
Till, predominantly clay, gray, brown cast, sandy, gravelly	3.0	229.0 - 232.0
Shale, green and brown	2.0	232.0 - 234.0
Dolomite, gray and shale, green	7.0	234.0 - 241.0
Dolomite, gray	3.0	241.0 - 244.0
	Total depth 244.0 ft	

KNE 42N7E-13.1h - Continued

SPLIT-SPOON SAMPLES

Sample	Depth (ft)	Recovery (in.)	Blows/6-inch hammer drop	N value*	Qp† (tons/ft^2)	Moisture content (%)
1	1.0 - 2.5	11	1- 2- 3	5	1.0	21.5
2	5.0 - 6.5	10	9- 11- 14	25	--	--
3	10.0 - 11.5	4	8- 7- 5	12	--	--
4	15.0 - 16.5	14	9- 11- 10	21	--	--
5	20.0 - 21.5	13	11- 12- 11	23	4.0	9.0[1] 8.1[2]
6	30.0 - 31.5	16	9- 12- 14	26	3.5	8.8
7	50.0 - 51.5	18	6- 8- 9	17	1.0	13.6
8	70.0 - 71.5	5	9- 10- 10	20	--	--
9	90.0 - 91.5	18	14- 21- 29	50	4.5+	9.5
10	110.0 - 111.5	18	15- 29- 39	68	4.5+	12.0
11	130.0 - 131.5	18	31- 53- 72	125	4.5+	11.9
12	150.0 - 151.5	10	45- 72-100	172	4.5+	9.9
13	170.0 - 170.5	6	154 (6-in. total drop)		--	--
14	190.0 - 191.5	18	23- 27- 27	54	1.8	20.0
15	210.0 - 210.9	8	63-100 (11-in. total drop)		--	--
16	230.0 - 230.7	7	71-100 (8-in. total drop)		4.5+	7.8

*Sum of hammer drops in last 12 inches.

†Unconfined compressive strength measurement made with pocket penetrometer.

[1] Upper 0.8 foot only. [2] Lower 0.3 foot only.

KNE 42N7E-13.1h - Continued

SIEVE AND HYDROMETER ANALYSES OF SPLIT-SPOON SAMPLES (in percent)

Sample	Distribution of all parts		Distribution of part < 2.0 mm		
	> 2.0 mm	< 2.0 mm	.062-2.0 mm	.004-.062 mm	< .004 mm
	Gravel	Sand, silt, clay	Sand	Silt	Clay
1	5	95	44	31	25
2	21	79	66	18	16
3	19	81	77	11	12
4[1]	13	87	83	8	9
4[2]	13	87	56	33	11
4[3]	11	89	79	12	9
5[4]	8	92	44	45	11
5[5]	14	86	52	28	20
6	10	90	36	40	24
7	9	91	35	36	29
9	4	96	40	28	32
10	4	96	33	31	36
11	6	94	25	40	35
12	3	97	24	35	41
13	0	100	65	24	11
14	0	100	1	24	75
15	21	79	74	13	13
16	1	99	39	45	16

[1] Upper 0.3 ft. [2] Middle 0.25 ft. [3] Lower 0.95 ft. [4] Upper 0.8 ft. [5] Lower 0.3 ft.

SIEVE ANALYSES OF SPLIT-SPOON SAMPLES (in cumulative percent)

Sample no. and depth (ft)	Tyler screen number											
	4	9	16	24	32	42	60	80	115	170	250	Pan
	Gravel		Sand									Silt, clay
[4]15.0 - 16.5	2.6	22.4	33.3	39.3	45.8	56.8	69.3	78.5	86.5	91.1	92.9	100.0
[13]170.0-170.5	0.0	0.7	2.1	2.9	4.1	7.9	16.2	30.0	55.3	74.3	82.5	100.0
[15]210.0-210.9	8.8	23.7	41.3	52.4	62.4	73.4	82.2	88.2	92.5	94.7	95.8	100.0

KNE 42N7E-13.1h - Concluded

SIEVE ANALYSES OF ROTARY SAMPLES (in cumulative percent)

Sample depth (ft)	Tyler screen number											
	4	9	16	24	32	42	60	80	115	170	250	Pan
	Gravel		Sand									Silt, clay
15.0- 20.0	11.4	23.5	57.7	73.5	82.6	91.1	96.3	98.5	99.4	99.6	99.7	100.0
60.0- 65.0	32.5	56.7	79.0	87.1	92.1	95.0	96.7	97.6	98.4	98.9	99.1	100.0
70.0- 75.0	9.1	34.6	58.7	69.5	79.4	90.6	96.4	98.2	99.1	99.4	99.6	100.0
170.0-175.0	0.0	0.3	0.7	1.6	4.5	17.2	49.8	74.8	90.2	96.1	97.8	100.0
180.0-185.0	0.3	0.4	0.8	1.7	3.5	10.9	41.2	71.4	90.5	97.5	99.1	100.0
210.0-215.0	15.7	56.6	76.8	81.9	85.2	88.1	91.5	93.7	95.5	96.7	97.4	100.0
225.0-230.0	22.1	43.4	55.3	60.5	66.1	74.4	84.9	90.7	94.1	95.8	96.6	100.0

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